TEXAS A&M ENGINEERING EXPERIMENT STATION

Turbomachinery Laboratory
Turbomachinery Research Consortium

Prediction of swirl in ESP impellers (Sungyon Lee; 1519K1)

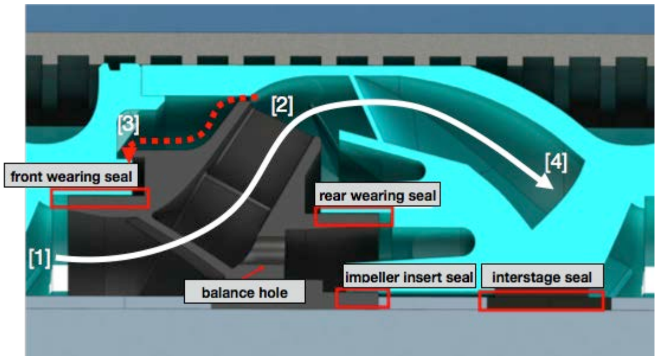

Figure 1: Detailed geometry of the ESP stage that consists of an impeller, a diffuser, and multiple seals [1].

Electrical submersible pumps (ESP) are artificial lift systems that are particularly useful in depleted oil fields but exhibit a limited operational life. The purpose of this TRC funded project is to investigate the leakage flow in the cavity space between the back of an impeller and the stationary casing inside an ESP pump. In particular, the excess swirl, or rotational energy, in leakage at the seal inlets contributes to rotordynamic issues and is at the center of our investigation.

Presently, we are performing numerical simulations of an axisymmetric leakage flow from the impeller exit to the entrance to a front-wearing seal (dashed arrow in Fig. 1) based on the SST turbulence model in ANSYS-CFX. The validity of our simulations is checked by directly benchmarking them against well-established experimental and numerical results in simplified rectangular cavity geometry [2-3]. In addition to direct validation, the same numerical simulations are extended to more realistic cavity geometry to compute swirl and flow profiles in the leakage flow. Our current focus is on identifying parameter space that minimizes or maximizes swirl initially for single-phase and eventually for two-phase flows.

[1] D. Childs, C. Norrbin and S. Philips. 2014. A lateral rotordynamics primer on electric submersible pumps (esp) for deep subsea applications. *43rd Turbomachinery & 30th Pump Users Symposia*.
[2] W. Björn-Christian. 2011. Theoretical, Numerical and Experimental Investigation of the Flow in Rotor-Stator Cavities with Application to a Centrifugal Pump. PhD Thesis, Universität Duisburg-Essen
[3] S. Poncet, M. Chauve and R. Schiestel. 2005. Bachelor versus Stewartson flow structures in a rotor-stator cavity with throughflow. *Physics of Fluids* **17**: 1964791.

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